

AMERICAN METEOROLOGICAL JOURNAL.

A Monthly Review of Meteorology, Medical Climatology, and Geography.

TABLE OF CONTENTS.

ORIGINAL ARTICLES AND TRANSLATIONS:	PAGE
The Meteorological Service of Russia, A. LAWRENCE ROTCH.....	241
The Inclination of the Wind.....	260
The Muir Glacier. PROF. J. W. CHICKERING, JR.....	265
CORRESPONDENCE:	
Westerly Winds and Storm Systems of the Temperate Zones. WALTER S. NICHOLS.....	269
CURRENT NOTES:	
J. Z. Houzeau.....	271
Rose Hedges vs. Snow Fences.....	272
Weather Predictions: Rainfall Maps. LORIN S. BLODGET.....	273
Hinman's Eclectic Physical Geography.....	274
Upper Air-Currents.....	275
Thunder-Storms at Brussels.....	276
China's Sorrows.....	277
Meteorology at the Cincinnati Exposition.....	278
Brief Notes.....	280
Hazen's Meteorological Tables. PROF. FRANK WALDO.....	282
Closing of the Stations on Pike's Peak and Mt. Washington.....	284
History of the Great Log Raft.....	286
Meteorological Conveniences.....	288

ANN ARBOR, MICH., U. S. A.:

METEOROLOGICAL JOURNAL COMPANY.

19, 21 and 23 Huron Street.

F. A. BROCKHAUS, Leipsic, Berlin, and Vienna, Agent for German and Austrian States.

Single Copies, 25 cents. Per Annum, \$2.00. In European Countries, \$2.25.

Entered at the Ann Arbor Postoffice as Second Class Matter.

AMERICAN METEOROLOGICAL JOURNAL.

AN ILLUSTRATED MONTHLY

DEVOTED TO SCIENTIFIC METEOROLOGY AND ALLIED
BRANCHES OF STUDY.

THE AMERICAN METEOROLOGICAL JOURNAL CO., Publishers and Proprietors,
Ann Arbor, Michigan.

M. W. HARRINGTON,
Director of the Astronomical Observatory, Ann Arbor, Michigan,

A. LAWRENCE ROTCH,
Proprietor of the Blue Hill Meteorological Observatory, Massachusetts,
Editors.

KITTREDGE & HOLMES, Managers.

PRICE.—IN THE UNITED STATES, - - - \$2.00 per year
" IN COUNTRIES OF THE POSTAL UNION, - - - 2.25 " "

Agent for German and Austrian States,
F. A. BROCKHAUS, Leipsic, Berlin and Vienna.

The editors solicit communications on all subjects having any bearing on Meteorology, Climatology, or American Geography. Correspondence on events of current interest is invited, and accounts of local newspapers concerning them will be welcome. Notes on local climate will be published and the columns of the JOURNAL are freely open for worthy communications on all matters within its scope. The editors do not hold themselves responsible for any communications which may be signed or attributed to other authorship than their own.

Contributors will be furnished free with five copies of the issue in which their articles appear. Additional copies can be furnished them at the rate of 12 for \$2.00. Reprints will be furnished, with cover and title, at the rate of \$6.00 per hundred for anything less than one form (16 pages); \$12.00 between one and two forms; and \$6.00 for each additional form or fraction. The order for reprints must accompany the copy.

Communications relating to the contents of the JOURNAL may be sent to either editor. Orders for reprints and subscriptions, and all other letters relating to business matters, should be sent to the

AMERICAN METEOROLOGICAL JOURNAL CO.,

Ann Arbor, Mich.

THE UNIVERSITY OF MICHIGAN.

More than 80 Instructors.

A LARGE AND CHOICE LIBRARY

Freely accessible to Students.

Its various departments of Physical Science, Biological Science and Engineering are thoroughly manned, and are provided with Laboratories, Observatories, Museums, Special Libraries, and Workshops.

It was the first Collegiate Institution in America to establish a special course in Meteorology.

Greatest possible Freedom in Studies allowed.

Fees very moderate. For further information address

JAMES H. WADE, Secretary,

ANN ARBOR, MICH.

THE AMERICAN METEOROLOGICAL JOURNAL.

VOL. V.

ANN ARBOR, OCTOBER, 1888.

No. 6.

ORIGINAL ARTICLES.

THE ORGANIZATION OF THE METEOROLOGICAL SERVICE IN SOME OF THE PRINCIPAL COUNTRIES OF EUROPE.

BY A. LAWRENCE ROTCH,

Member of the German Meteorological Society, and Fellow of the Royal (London) Meteorological Society.

THE METEOROLOGICAL SERVICE IN RUSSIA.

History.—The first meteorological observations in Russia were begun by the Academy of Sciences at St. Petersburg, in 1726, and were followed in the latter half of the last century by observations at eight stations.

The impulse given to the study of magnetism by Gauss and Baron von Humboldt, in the early part of the present century, had a great influence on the progress of meteorology. The Academy of Sciences had established a number of magnetic observatories in different parts of Russia, and in 1833 these were made to include meteorological observations by Kupffer, who published them in the *Annuaire Magnétique et Météorologique*.

The Central Physical Observatory of St. Petersburg, founded by the Department of Mines in 1849, was intended to be not only the headquarters of the meteorological stations, but also a physical laboratory, and an elaborate series of experiments on the elasticity of metals was here conducted by Kupffer. The

results of the magnetic and meteorological observations were published under his direction for many years in the *Annales de l'Observatoire Physique Centrale* and in the *Correspondance Météorologique*. In 1849, the Russian system embraced 8 stations of the first order and 48 stations of the second order, the cost of publication of their observations being borne by the Department of Mines. Owing to the small staff and funds the stations could not be inspected, the observations became inaccurate and the number diminished.

On the death of Kupffer, in 1865, the Central Physical Observatory was transferred to the Academy of Sciences under the direction of Prof. Kaemtz, of Dorpat. At his decease in 1867, Dr. Wild, of Berne, was appointed to fill the position. Under his energetic superintendence the needed reorganization of the Physical Observatory and the dependent stations was effected in 1871, and their present development and efficiency brought about. The metric system was adopted in 1870 and the form of publication changed then, and again in 1878, to conform to the recommendations of the International Congress.

Organization.—The Russian territory is the largest covered by any meteorological service in the world. It lies wholly in the temperate and frigid zones, and includes 170° of longitude and 30° of latitude. The stations are, of course, very unequally distributed, whole governments in East Siberia having not a single meteorological station. The system of stations under the control of the Central Physical Observatory embraces the whole of the Russian Empire, except the Grand Duchy of Finland, which has a central observatory of its own at Helsingfors.

Besides the first order station of Pawlowsk there is the observatory of Tiflis, which publishes its own observations and serves as a local center for the stations in its neighborhood. Two new magnetic-meteorological observatories have been established at Catherinenburg, in West Siberia, and at Irkutsk, in East Siberia, which are to serve as the central stations for these regions. There are several other stations intermediate between those of the first and second orders, including the Central Physical Observatory at St. Petersburg. These are all

controlled by the Academy of Sciences, but there is an independent observatory at Dorpat, which publishes its detailed observations. The number of stations of the second and third order (chiefly the former) reporting to the Central Physical Observatory has increased to about 280 in 1887, which number includes 16 stations in the Tiflis series and 54 lighthouses and harbor stations, depending on the Hydrographic office. There are besides about 600 rain and thunder-storm observers. The observers are mostly volunteers, but receive the publications gratis, and occasionally titles and presents. Those on the coast, who also display the storm signals, are paid 180 R. (\$90) a year, and some of those in the Caucasus and in Turkistan are paid by the local administrations.

THE CENTRAL PHYSICAL OBSERVATORY.

The Central Physical Observatory is a Government institution under the direction of the Imperial Academy of Sciences, and like the latter belongs to the Ministry of Public Instruction. The Observatory has these functions, as the headquarters of the Russian meteorological service: (1) In addition to the regular meteorological observations the instruments for the stations are verified and repaired, and (2) the records of the stations are checked and published. It is (3) the central station for the department of weather telegraphy and maritime meteorology, and (4) the seat of the administrative department of the service and the residence of the director during most of the year.

The Observatory is situated in St. Petersburg, on the south side of the island Wassili Ostrow, near a branch of the Neva. The neighborhood is occupied largely by factories, and the smoke from them, the heavy teaming, and the passage of iron ships, are inconveniences for magnetic and meteorological observations which led, in 1879, to the removal of all the magnetic and the best meteorological apparatus to Pawlowsk. Though there are still a number of registering instruments at St. Petersburg, the indications only of the anemometers are reduced for publication. The building is two stories high, with a tower, on which are exposed the anemometers, etc. In a garden at the

rear are smaller buildings, with meteorological instruments. There is a library of about 20,000 volumes.

(1) For the verification of instruments there are a number of standards, with apparatus for making the comparisons. The normal barometer has been thoroughly investigated by Wild. It is a siphon tube of more than 25 mm. internal diameter. The graduation corrections and coefficient of expansion of its scale were determined, and correction was made for the pressure of any air the vacuum chamber contained, and for any slight deviation in density of the mercury with which it was filled from the density of pure mercury. It is observed by a cathetometer with two telescopes, the pointings with micrometer wires being made directly to the tops of the mercurial columns. Its readings are 0.10 mm. lower than the Kew normal. On account of the tremors caused by passing wagons it is only seldom that the normal barometer can be used, and a similar instrument is therefore to be mounted at the Pawlowsk Observatory, where observations can be made at all times. Improvements have been made in the Combes' rotation apparatus for testing anemometers, which was used by Dohrandt in his determination of their constants. The anemometer is placed on the end of a long arm, which is rotated by a gas motor. The number of turns of the arm and of the anemometer cups are electrically recorded on a chronograph, and a fixed air meter gives the velocity of the air set in motion. Most of the meteorological apparatus is duplicated at Pawlowsk, but the anemometer equipment differs. Their motors are exposed 2.5 m. above the tower, and 23 m. above the ground. The Sprung-Fuess anemograph, by means of rolls driven by Robinson's cups, draws out paper at a rate proportional to the wind's speed, while a pencil each hour moves transversely across the paper, upon which a pencil corresponding to the wind's direction rests. A modified Richard anemograph records wind velocity and direction electrically. The direction pencils mark whenever the fan wheel has made one hundred turns, and the time-scale is marked on the margin of the paper, which is unrolled by clock-work. In the Wild-Hasler register the motions of the cups and vanes are transmitted to

horizontal spirals, against which a moving band of transfer paper is pressed intermittently, producing a similar, except non-continuous, trace to that of the Beckley instrument, of which there is a model here. Hagemann's aspiration anemometer measures the effect of the wind in blowing across the end of a vertical pipe, by means of a manometer. The indications of a Casella anemometer for five minutes before and after the periodical observations, together with the wind direction, are transmitted electrically to the observing room. The Wild wind-vane and pressure-plate is thus constructed: On the top of a vertical rod turned by a vane is a plate turning on a horizontal axis and moving along a graduated arc. The angular deviation of the plate from the vertical indicates the strength of the wind.

Several of the standard rain gauges are exposed at varying heights above the ground and are protected from the influence of the wind by Nipher funnels. One set of gauges 1 m. above the ground, is surrounded at a distance of 1 m. by a fence 2 m. high. This is a plan commonly adopted, and is as efficient as the more expensive Nipher funnel.

A Limnigraph, constructed by Hasler and Escher, registers each ten minutes the height of the water in the Neva by means of a connecting pipe.

The mechanical workshop of the observatory has to look after the construction of new and the repair of damaged instruments, and the furnishing and forwarding of instruments to the newly established meteorological stations. The observatory undertakes the filling of the barometers intended for the various stations, except for the more remote ones where the barometers are filled locally.

(2) The meteorological observations sent to the Central Observatory are generally checked by the staff of the observatory who attend to this work, by comparison with the data of synoptic charts and with the observations of neighboring stations, and the accuracy of the reductions is examined; finally, the means of the verified tables are extracted for publication. There is a special department for the direction, collection and discussion of the rainfall and thunder-storm observations.

The Caucasian stations, under the superintendence of the Tiflis Observatory, send their observations to that observatory, and the latter, after they are checked, sends them to the Central Observatory ready for printing.

Publications.—The observations from the observatories and from the meteorological stations in Russia are published in the Annals of the Central Observatory. The following volumes have appeared: *Annales de l'Observatoire Physique Central*, 1847–69, (a continuation of the *Annuaire Magnétique et Météorologique*, 1835–46, issued by the Administration of Mines). From 1850–64 results of the observations and other communications were published in the *Correspondance Météorologique*. In 1870 the Annals first appeared with the German title, *Annalen des Physikalischen Central Observatoriums*, and since 1878 have been divided into two parts; the first part contains the hourly observations of Pawlowsk and other supplementary observations; the second contains the observations of the second and third order stations, according to the international form. The contents of the *Annalen* for 1886, is as follows: Part I.—Introduction to the observations at Pawlowsk and St. Petersburg. Direct meteorological observations at Pawlowsk. Results of the registering meteorological instruments at Pawlowsk, including: barograph, thermograph, hygrograph (absolute and relative humidity), ombrograph and heliograph. Results of the magnetograph, including: declination, horizontal and vertical intensity. Hourly wind observations at St. Petersburg, with daily means of the components and resultants, and special observations. Rainfall observations in 1886, and thunderstorm observations in 1885 and 1886. Part II contains the observations at 249 second and third order stations, 199 of them being monthly and annual means only, [published according to the international form]; also the wind observations at 32 lighthouses furnished by the Hydrographic Department of the Ministry of Marine. The text is both Russian and German.

Discussions by the staff of the Observatory, relating to meteorological and magnetic phenomena in Russia, are published under the superintendence of the director in the *Repertorium*

für Meteorologie of the Academy of Sciences. This work which is in French and German (chiefly the latter) was commenced by Kämtz, and is now in its eleventh volume. In the supplement have appeared Wild's great discussions: *Die Temperatur Verhältnisse* and *Die Regen Verhältnisse des Russischen Reiches*. This is undoubtedly the most important series of meteorological and magnetic memoirs extant. Detailed information as to the work of the Central Observatory and of its subordinate institutions is given in the yearly reports of the director. The volumes for the years 1849-64, have appeared under the title *Comptes Rendus du Directeur*; from the year 1869 the *Jahresberichte* have been published, and in recent years these have been printed in the *Repertorium für Meteorologie*.

(3) *Weather Telegraphy and Maritime Meteorology*.—The system of weather telegraphy in Russia was organized by Kupffer in 1864, but little was done until 1872, when the Central Physical Observatory in co-operation with the Hydrographic Department commenced the publication of a daily weather bulletin containing the telegraphic reports from 55 stations in Russia and Asia, and began the study of the storm tracks by means of synoptic charts. In 1874, storm warnings were commenced, which in 1887 were extended to the ports on the Black Sea.

The Central Physical Observatory receives daily weather reports from 80 Russian and 55 foreign stations. These reports are sent in five-place groups of figures by the international code, and contain the 7 A. M. observation, with the 9 P. M. observation of the preceding day. Noon telegrams are received from 13 foreign and 29 domestic stations. The observations are made on local time, and on account of the great advance of time between St. Petersburg and the extreme eastern stations, the reports from the latter frequently arrive before those from the foreign western stations. The 7 A. M. and 9 P. M. observations are charted and a variation chart made, showing the changes of pressure in 12 hours and the temperature changes in 24 hours. These charts are not published and no weather predictions are issued. Storm warnings are, however, sent to 15 ports on the Baltic

and to ports on the Black Sea and the inland lakes, the Fitz Roy system of signals being employed. The warnings are considered verified, when the wind at one-third of the stations of a group reaches a force of 7 Beaufort; partly verified when at these stations it reaches only 1 or 2 of that scale. The warnings are called late when the storm comes (after 7 A. M.) before they arrive at one-third of the stations. The storm is said not to have been predicted when no warnings are issued and its force exceeds by 1 the normal storm force. The verification is now estimated, as in England, by classing the verified with the partly verified warnings, and was for 1885, 89 per cent., and for 1886, 84 per cent.

About 3 P. M. a lithographed *Bulletin* is issued, containing the 7 A. M. reports from 115 Russian and foreign stations of these data:

Barometer in mm. reduced to 0° C.

Barometer reduced to 0° C. and sea level.

Change in last 12 hours.

Temperature in C.°.

Deviation from normal.

Change in 24 hours.

Relative humidity in per cent.

Cloudiness.

Wind direction and force (Beaufort).

Precipitation in mm.

Hydrometeors, etc.

The *Bulletin* contains also data concerning the weather of the previous day at St. Petersburg, and a summary of the general weather conditions in Russian and German text.

These *Bulletins* are distributed gratis by post and are copied in part by the newspapers. Two of these print weather maps the next morning, by the Rung process.

In exchange for the telegrams received, the Central Physical Observatory sends out six dispatches to foreign institutions, and nine to domestic ones, containing the principal Russian reports.

The branch of Maritime Meteorology was organized in 1876. It is mostly concerned with the management of 53 coast stations,

of which 37 are maintained by the Ministry of Marine. Very few ships' logs are received.

(4) *Staff and Budget.*—The staff of the Observatory consists of the director, Professor Dr. H. Wild, an assistant, a secretary, two physicists, two observers, two computers, a steward and a mechanic, at a combined salary of 16,000 R. (\$8,000). The director receives about 2,700 R. (\$1,400) in addition to his salary as Academician, and a personal allowance. A. Schönrock is the special inspector of stations.

The department for Weather Telegraphy and Maritime Meteorology has a chief, M. Rykatschew, who manages it, two physicists, two adjuncts, one computer, two draughtsmen, and one lithographer, at a combined salary of about 11,000 R. (\$5,500). In addition to these permanent officials there is the necessary number of computers, writers and servants, paid by wages provided from special funds. The director, the secretary and the steward have apartments in the Observatory. The total appropriation for this Observatory, with its various departments, amounts to about 70,000 R. (\$35,000) annually. The other Observatories generally have special appropriations. Free telegrams and postage are allowed.

THE PAWLOWSK MAGNETIC AND METEOROLOGICAL OBSERVATORY

This Observatory, which is the chief observing station of Russia, and one of the best meteorological and magnetic observatories in the world, is situated in the neighborhood of the small town of Pawlowsk, 25 km. south-southeast of St. Petersburg, upon a plain forming part of a park. The land was given by Prince Constantine, and the Observatory was erected in 1878 at a cost of about 140,000 R. (\$70,000). The Observatory proper is a two-story brick building with a central tower. On either side are the residences of the director and assistants. To the north are the thermometer shelters, etc., and the wooden magnetic pavilion, while buried under an artificial hill are the vaults for the magnetic variation apparatus.

Description of the Observatory.—As few meteorological observatories have been specially designed for their work, a descrip-

tion of that at Pawlowsk is given. On the ground floor is a workshop with forges, and a laboratory for the manipulation of physical apparatus. This opens into a corridor containing the electric batteries, from which leads a chemical laboratory and a photographic dark-room. In the center of this floor are the hot-air furnaces for heating, the rest of it being occupied by the janitor's rooms. At one side of the workshop is an outbuilding containing the pumps which force water from the well up to the reservoir in the tower. On the north side is a large instrument shelter open below and to the north, and enclosed on the other sides by louver work. A spiral staircase—besides the principal one—leads from the corridor up to the first floor, with the offices of the director and superintendent, the library and the work-rooms for the assistants. A circular room in the center, directly over the heating apparatus, contains the instruments which require a constant temperature, such as the normal clocks, chronometers and barometers. In the tower are the registers of the anemometers, which are themselves exposed on the top of this octagonal structure, 23 m. high, the hollow walls of which serve as chimneys.

The Meteorological Instruments.—The Observatory possesses a complete series of self-registering apparatus, besides the instruments of a second order station exposed in various ways. Much of the apparatus registers on the Wild-Hasler principle, which consists in unlocking each ten minutes, by means of an electric current, an anchor which presses a steel point against a band of paper drawn from a roll. Synchronous time is insured for all the instruments by having one clock in the Observatory make and break the circuits, the wires for the isolated instruments being laid underground. The values of the curves formed by these punctures of the styles may be ascertained by a scale counted from a fixed zero line.

The normal barometer in the physical laboratory has Hagemann's mercury pump for producing a vacuum, means for testing it, and for measuring the height of the mercury by a cathetometer. The control barometers are made by Turretini, Fuess, and Adie, and are kept upstairs. The two former are a

combination of the Fortin and the siphon barometers. In the Wild-Fuess the long tube is curved and joins the short tube, while in the Wild-Turettini the tubes are parallel. In both, the mercury is brought to an index in the short tube by screwing the cistern, and unequal capillarity is avoided. There is a vernier on this index, so that the measurements, ordinarily made upwards, can be made downwards as a check. The Wild-Hasler barograph has a fixed cistern, with the tube suspended from the end of a balance. The other end has a suspended cistern in which dips a similar fixed tube filled with mercury and above with spirit, whose expansion alters the quantity of mercury, and so neutralizes the effect of the temperature upon the mercury in the other tube of unequal bore. A lever extending downwards from the fulcrum of the balance registers as in all the Wild-Hasler instruments. The average difference between it and an ordinary mercurial barometer is ± 0.10 mm., which is the same as for the photographic barograph previously used. A Sprung-Fuess barograph has recently been installed, and there are other instruments, such as the registering aneroids of Hottinger and Richard.

The shelter on the north side of the observatory contains thermometers, etc., which can be read through a glass door by a telescope; but the normal instruments, whose indications are published, are exposed in isolated shelters over grass. As Wild has given much attention to thermometer exposure, the following description of it is given. The system embraces a zinc screen inside a wooden hut. The hut has four posts about 1.50 m. apart and 3 m. high, upon which rests a double roof sloping down towards the south. For a distance of 1 m. below the roof the east, west and south sides have a double wall of boarding corresponding to the double roof. The north side is entirely open. This hut contains the cylindrical screen, to which a ladder gives access from the ground. The instruments are fixed to a vertical rod, around which two segments with conical tops revolve, the inner being elliptical. For reading the instruments the two segments are brought together, which gives an opening through the screen. In its bottom is a ventilating fan driven

by a cord from a pulley wheel below. This being worked a minute or two before an observation, air is driven into the screen and a proper reading of the psychrometer obtained. The instruments used are a psychrometer, between whose thermometers is a hair hygrometer, and beneath them a maximum and a minimum thermometer. Experiments made with screens of zinc and polished brass showed small differences; in other experiments the thermometers were read by a telescope, to eliminate the disturbing effect of the observer. In the Wild-Hasler thermohygrograph the temperature is recorded by a metallic coil, and the humidity by a stretched hair. Though placed in an isolated hut, provided with a ventilating cowl, its action is sluggish. The turn-over thermometers of Negretti and Zambra have been abandoned as inaccurate, and the thermograph and hygrograph of Richard are now on trial. The terrestrial radiation thermometers, a maximum, a minimum, and an ordinary instrument graduated to 0.2° , lie on the grass. About 1 m. above is a Hicks black-bulb solar-radiation thermometer, read daily at 1 p. m. The soil thermometers are buried in sand. On its surface is an ordinary and a minimum thermometer. Four duplicate sets of vertical thermometers, enclosed in wooden tubes, are sunk at depths of 0.40 m., 0.80 m., 1.60 m., and 3.20 m. Their holes are lined with glass tubing, with a large copper plate at the bottom to promote conductivity and to exclude the ground water, but with the deepest thermometers the latter object is not accomplished. Another set of four horizontal thermometers are buried at depths of 0.05 m., 0.10 m., 0.20 m., and 0.40 m. below the surface. They are read by drawing them horizontally into a pit, ordinarily covered with a trap-door. Those thermometers which are 0.40 m., or less, below the surface are read tri-daily; those deeper, once daily.

The standard rain-gauge is a zinc cylinder about 40 cm. high, having a turned brass rim, with a vertical inside edge, of 20 sq. cm. area. Near the bottom is a conical shield pierced with holes, and in the side below is a spout with a cap. The rain or melted snow is poured into a mm. graduate. The gauges are exposed 2.5 m. above the ground, and are surrounded by Nipher

funnels from which good results have been obtained. Precipitation is measured at 7 A. M.

An ombro-atmograph constructed by Hasler and Escher is in an isolated shelter, and operates thus: A pan filled with water and exposed to the sun and wind rests on the platform of a balance connected with a register. By evaporation the weight of the pan is lessened and the curve deviates to the right. If rain falls the overflow passes through a pipe in the evaporating pan into a collector, increasing the weight and causing the curve to bend to the left. In winter a high cylinder, slightly conical, replaces the rain receiver, and the snow collected is weighed. For direct observations of evaporation a Wild atmometer exposed in the thermometer hut is used. In this instrument a vessel of 40 sq. cm. rests on a bent-lever balance, which is generally clamped fast. Each mm. of water corresponds to 2.5 gr. or one-half of a division on the scale. The dish is weighed at 1 P. M., and the water brought within 5 mm. of its edge. A similar empty dish stands near the full one, and in case of any dust or snow being suspected to have blown into the shelter its amount in the empty dish is added to the apparent evaporation in the other dish. An ombro-anemograph registers the precipitation by receiving it on a water-wheel (snow being melted by hot air), and the direction and velocity of the wind by styles for each direction. The Robinson cups and vane for this instrument are placed near the gauge.

The standard anemometer exposure is not good, as the trees on all sides but the east are nearly level with the motors, which are about 4 m. above the tower. The velocities here recorded are less than at St. Petersburg. The indications of the normal anemometer, whose constant has been determined in St. Petersburg, are transmitted electrically to the observer's room, the velocity being estimated for ten minutes. There is a wind component integrator of von Oettingen, with a mechanical connection between the motor and the integrator, consisting of a horizontal disk turned by the cups upon which one of four direction wheels controlled by the vane rests. Each revolution of the wheel is electrically transmitted to the printing apparatus which prints

the total number of miles travelled by each wind upon a band of paper. There is also a Beckley anemograph of the English type.

A Campbell-Stokes sunshine recorder stands under a glass shade on the south parapet of the tower, and registers the amount of bright sunshine by charring a strip of mill-board. An electrometer attached to a Mascart water collector is now observed tri-daily, but an apparatus for continuous registration is being constructed by Edelmann.

The data from the preceding instruments are reduced, and with any extra observations are printed monthly. Tri-daily eye observations are made as at the second order stations, besides other direct control observations. Much experimental work is also carried on.

The Magnetic Observatories and Instruments.—The magnetic equipment is very complete. Besides the apparatus for absolute determinations of terrestrial magnetism, there are magnetometers arranged for direct measurements of variation; also instruments for determining the intensity of earth currents.

In the middle of a field is a cruciform wooden building, entirely free from iron, for absolute measurements. An outside corridor receives the heat from the hot air furnaces by which the temperature of the inner room is kept constant, this being further effected by triple outside doors. A wooden tube extending above the roof, set parallel to the earth's axis, permits the pole star to be seen in order to determine the azimuth of the magnetic meridian. Astronomical determinations are carried on in an adjoining building. By means of a transit instrument two sights, each 140 m. distant, can be seen nearly in the astronomical meridian. The pillars upon which the instruments rest are built up from the ground independently of the floor. Absolute measurements are now made twice a month, and formerly more frequently. For declination a magnetic-astronomical universal instrument, constructed by Brauer from Wild's designs, or that of Meyerstein, whose collimator magnet is observed by

a transit instrument of Döring, is employed. An inclination instrument of Dover has two needles which are demagnetized by the magneto-electric machine of Siemens and Halske in the physical laboratory. There are two Weber induction inclination instruments on either side of the needle inclinators. The horizontal intensity is determined by a magnetic theodolite of Brauer, but a combination of Gauss' and the bifilar method has been used. In connection with the International Polar Expedition, measurements of the absolute inclination were made with the needle and induction apparatus.

The underground pavilion for the magnetic variation instruments is of elliptical form, and contains two vaults, 6 m. broad and deep and 5 m. high, separated by a corridor which surrounds the vaults, and has at the ends the furnaces for maintaining them at a uniform temperature of 21° C. Over the vaults is an air space, and above this the earth is piled to a depth of 1.5 m. These precautions, with triple doors and ice in summer, bring the annual range of temperature within 1° C. The instruments for direct readings occupy one vault, and the Kew magnetograph the other. The instruments are a unifilar and a bifilar magnetometer by Edelmann. These, with a Kupffer variation instrument, are observed tri-daily, and signals can be given to the absolute magnetic pavilion for synchronous observations. Earth currents through 1 km. of buried cables lying in the four cardinal directions are measured by a galvanometer. The reduction of the curves from the photographic register is not done by the Kew measuring apparatus, but with glass scales, after the method of reading the curves from the meteorological instruments.

Staff and Budget.—The Pawlowsk Observatory is a branch of the Central Physical Observatory, and is managed by the director of the latter. A superintendent, Dr. E. Leyst, has the immediate charge of the Pawlowsk Observatory, at a salary of 3,600 R. (\$1,800), and under him are a physicist, three observers, a mechanician, and a steward, who have apartments provided. The salaries amount to about 9,000 R. (\$4,500), and the total expenses to some 25,000 R. (\$12,500) annually.

THE EQUIPMENT OF THE STATIONS AND THE METHODS OF
OBSERVATION.

The observations at stations of the 2d order include tri-daily observations of pressure, temperature, humidity, direction and force of wind, clouds and precipitation; and a number of stations also observe earth temperatures and evaporation. At stations of the 3d order one or more of these elements are not observed. In this class are included the lighthouse stations of the Baltic Sea, where only wind observations are made.

The instruments are partly bought by the observers and partly loaned to them by the Central Observatory, where they are tested before being distributed. Occasionally the stations are inspected, but on account of the inaccessibility of some of them this cannot be done regularly. To regulate the clocks in places where telegraphic time is not available the equatorial sun-dial of Fléchet is supplied. The barometers are the Wild-Fuess siphon or the Wild-Turettini siphon instruments already described. The tubes are generally 8 mm. in diameter with a vernier reading to 0.1 mm., and cost about 80 R. (\$40), verified. Some remote stations have closed-cistern barometers, but aneroids are only used in exceptional cases. The psychrometer for measuring the temperature and humidity of the air is divided to 0.2° C. The maximum thermometers have either a steel index, or a mercury one separated by an air-bubble or by a constriction in the tube; the minimum are alcohol ones costing about 8 R. (\$4), verified. The hair hygrometer may be used whenever the air temperature is below 0° C., its indications being corrected at higher temperatures by the psychrometer. These instruments are contained in the zinc screen, already described, which was adopted by the Central Physical Observatory in 1874. It may be exposed 0.30 m. from a north window, but whenever possible it is placed in the isolated hut adopted for the Russian stations in 1870, which has also been described. For stations in low latitudes, with hot, calm summers, the ventilators mentioned are attached to the shelters. The Wild wind-vane and pressure-plate has eight divisions of arc, but on the coast and at other

places where the wind often attains a velocity of 20 m. per second, the vane has two plates of which one is four times as heavy as the other and corresponds to twice the wind velocity for the same angle of deviation. For converting these angles into metres per second tables are used. The standard rain gauge, previously described, is either hung or set on a post from 2 m. to 2.5 m. above the ground, and to prevent the snow from blowing out the methods used at Pawlowsk are recommended. Another device, which is not so good, is a cruciform piece of metal placed in the gauge, of which in winter two are interchangeable. The cost of the verified gauge is about 34 R. (\$17), but there is a simpler form at 10 R. (\$5).

The observations are made according to the New Style (Gregorian) calendar at 7 A. M., 1 and 9 P. M., local time. They are recorded in a small book and are afterwards copied into a monthly table, and both book and table, either with or without the necessary reductions, are sent at the end of the month to the Central Physical Observatory. The reductions are effected by Wild's tables furnished as a supplement to his *Instruction für Meteor. Stationen*, a new edition of which in German and Russian has recently been issued by the Academy of Sciences. The monthly table is a folio sheet and contains on one side the latitude and longitude of the station, the name of the observer, the date, the height of the barometer above the sea, and of the other instruments above the ground. On the other pages are these headings for each day of the month:

Barometer reduced to 0° in mm., 3 observations, their sum and mean.
 Air temperature in C° " "
 Wet bulb thermometer, 3 observations.
 Absolute humidity in mm., 3 observations, their sum and mean.
 Relative humidity in per cent. " "
 Hair hygrometer " "
 Direction and force of wind (16 points and m. per second), 3 observations.
 Direction of motion of clouds at 1 P. M.
 Cloudiness (0 - 10), 3 observations.
 Precipitation, in mm., at 7 A. M.
 Maximum and minimum thermometers at 9 P. M.
 Remarks, including hydrometeors according to the international symbols.

At the top the pages are the sums and means of these columns, and a table showing the frequency of the wind from each of the 16 points with its mean force in m. per second, the maximum and minimum temperature and dates, the maximum and minimum pressure and dates, the minimum relative humidity and date, the greatest precipitation in 24 hours and date, the number of days with snow, hail, sleet, fog, thunderstorms and gales, the number of clear, fair and cloudy days, and the number of days with the maximum and minimum temperature below 0° .

OTHER OBSERVATORIES, ETC.

The observatories at Tiflis, Dorpat and Nicolaieff partake partly of the nature of stations of the first order, and partly of the nature of central stations for their respective districts.

Tiflis.—The Physical Observatory at Tiflis, with its dependent meteorological stations, has been directly controlled by the Central Observatory since 1883, when the governership of the Caucasus was abolished. Its duties consist in regular magnetic and meteorological observations, and the physical and climatological investigation of the Caucasus district through its subordinate stations. In addition to the instruments required for the usual meteorological observations at a station of the second order, this observatory possesses instruments for determining earth temperatures at various depths, evaporation, radiation, etc. It has also a Hasler barograph, thermograph, hygrograph and anemograph, and a number of magnetic instruments. Since the year 1880, when hourly eye observations of the magnetic and meteorological elements were commenced, these observations have been printed in *extenso* in *Beobachtungen des Tifliser Physikalischen Observatoriums*, and in addition the observations of earth temperature have been printed separately. Observations made ten times daily, from 1873 to 1878, have appeared in *Materialen zu einer Klimatologie des Kaukasus*. The director is Professor J. Mielberg.

Dorpat.—Up to the year 1867, Dorpat was a station of the second order; after this time, through the efforts of A. von Oet-

tingen, it became a station of the first order, making eye observations each three hours from 7 A. M. to 10 P. M. The self-registering apparatus in 1880, comprised a Kreil barograph and thermograph and two of von Oettingen's wind component integrators. No regular magnetic observations are made. The observations have been published *in extenso* from the year 1867, under the title, *Meteorologische Beobachtungen in Dorpat*. The observatory is directed by Professor K. Weihrauch, Professor of Physical Geography and Meteorology at the University.

Nicolaieff.—The Hydrographic Department of the administration of the Black Sea fleet and ports, has the immediate supervision of the meteorological station at Nicolaieff, and of the observations taken on the ships and at the ports and light-houses of the Black Sea. It inspects the regular stations and sends their observations to St. Petersburg. The station has a barograph and anemograph whose indications are not reduced. The Department issues a daily weather bulletin, showing the weather conditions prevailing over the Black Sea.

The observatories of the Department of Mines, which were formerly subordinate in their scientific relations only to the Central Observatory, and the new Central Observatories of Catherinenburg and Irkutsk, are now controlled by the Ministry of Public Instruction. Other districts have central administrations for the more remote stations. For instance, the meteorological stations in Turkestan are superintended by the Taschkend Observatory, those on the Black Sea by the Hydrographic Section at Nicolaieff, and those on the Pacific coast by the Hydrographic Section at Wladiwostok. The observations from these stations are sent to the Central Observatory at St. Petersburg, like those which belong directly to it, for examination and publication. For the maintenance of the meteorological institutions in Russia, the government expended in 1882 about 130,000 R. (\$65,000), in which sum the cost of the maintenance of the Taschkend Observatory with its subordinate stations and the expenditure of the Ministry of Marine for meteorological purposes were not included.

THE INCLINATION OF THE WIND.*

The wind is ordinarily represented as blowing horizontally, or rather, parallel to the earth's surface. Daily observation, however, shows us that this is far from being the case. We constantly see pieces of paper and dead leaves rise more or less rapidly under the influence of a gust of wind, sometimes to a considerable height. On the other hand we see smoke from chimneys driven downwards, and if, during a storm, we are on the sea-shore we notice the liquid mass become hollowed, giving rise to huge waves, which could not happen if the air flowed horizontally along the surface of the water. Careful observation of meteorological phenomena has taught us that all cyclonic movements, large and small, which originate in the atmosphere, include vertical currents more or less marked. These currents exist in tornadoes, in water-spouts, in thunderstorms, and even in the little whirlwinds which are seen to form in summer in the country. If, taken as a whole, the atmosphere is carried in a direction parallel to the exterior of the earth, the interior of this mass is constantly furrowed in all directions, by ascending and descending currents which naturally exercise a considerable influence upon the meteorological conditions of the lower regions of the gaseous ocean where the reaction of all these movements is most felt. There is reason to be astonished that the study of the currents from the point of view of their frequency, their intensity, their greater or less inclination to the horizon, etc., has been generally neglected up to the present time. All the observatories, and a great number of meteorological stations, possess anemometers giving the wind's horizontal component, but no attention has been paid to the vertical component.

The first person, very probably, who practically took up this interesting question was M. C. Montigny, known by his researches on the scintillation of the stars. In 1867, M. Montigny undertook some experiments on the inclination of the wind at various stories of the Anvers Cathedral by means of an

* Translated and abridged from *Ciel et Terre*.

apparatus consisting of a double vane acted upon by the vertical component of the wind and kept in the direction of the prevailing wind by another double vane turning horizontally. The principal results deduced from these experiments were as follows: (1) At the dial gallery only (210 feet above the ground) the inclinations (between E. S. E. and S. S. W.) have a + sign, which denotes a plunging wind for these azimuths. For the other directions at this gallery and for the winds of all azimuth at the other two galleries (292 and 341 feet high, respectively), the inclination of the wind is negative; the action of the wind thus appears to be directed upwards for all azimuths in the two upper galleries; (2) the inclination is less ($-2^{\circ} 13'$) at the dial gallery than it is at the next gallery ($-8^{\circ} 4'$), and especially than at the upper gallery, where it is greatest ($-12^{\circ} 22'$); (3) the maximum inclination corresponds with E. to N. winds at each gallery; (4) the minimum inclinations from a tolerably regular series between the directions S. E. and S. at all the galleries. Hence M. Montigny concluded, while admitting the influence of the tower upon the inclinations at the various galleries, that the differences which distinguish the mean inclination of different winds are in part characteristic of each wind; that is to say, these differences result less from local than from general causes, which need investigation.

These observations gave only the degree of inclination of each wind without stating the amount of the vertical component of the wind's velocity, which is of great importance in theoretical and applied meteorology. Several years' observations of these data, which were undertaken in 1881 by Fr. Dechevrens, director of the Zi-Ka-Wei Observatory in China, have been discussed by the author. The apparatus used, to which the name clinometer is given, has the external appearance of Robinson's anemometer, the cups being replaced by four fans inclined at 45° and fixed by arms to a vertical axis so that they turn in a fixed horizontal plane. In opposition to the notation employed by M. Montigny, Fr. Dechevrens considers positive values as referring to ascending winds and negative values to descending winds. The apparatus was placed 23 feet above a platform

which is 108 feet higher than a vast plain extending on all sides as far as the eye can see. Such were the very favorable local conditions for observations in the region of the monsoons.

GENERAL RESULTS AT ZI-KA-WEI.

The observations in 1881 had shown that the movement of the air was not horizontal, and those obtained in 1884, 1885 and 1886 have amply confirmed this fact. Thus in December, 1884, notwithstanding great variations which sometimes carried the air upwards at an inclination of 25° with a vertical velocity of 10 feet a second, and sometimes threw it downwards with a vertical velocity of nearly 9 feet, the mean inclination of the wind from 744 hourly observations was $+11^{\circ}$ (ascending). In January and February, 1885, the variations were less great, the mean inclination for these two months being 14° and 15° , respectively. During the winter, 1884-85, the greatest inclination during 24 hours was $22^{\circ} 3'$ with an ascending wind, and 6° with a descending one. The mean hourly value of the vertical component during the year 1886 was 1.26 miles, while the hourly velocity of the horizontal wind rose to 13.05 miles. The relation of these two components is 0.11, corresponding to an angle of $6^{\circ} 20'$, which was, therefore, the mean positive inclination (ascent) of the wind during that year. The smallest mean monthly inclination was $3^{\circ} 7'$; the greatest, $6^{\circ} 38'$. The least mean daily inclination was $0^{\circ} 11'$; the greatest, $8^{\circ} 48'$. Though these inclinations may seem small, they become important if we consider the limited height of the atmosphere and inclinations of the wind, which can carry the surface air to elevations of 6 or 7 miles in an hour, or which can precipitate on the ground, in the same time, air drawn from heights of 5 or 6 miles, merit the attention of meteorologists. Besides, a mean inclination of 6° at 131 feet above the ground, suggests that at a greater height it would be larger and the descending currents more marked. Thus the observations of an inclination-anemometer upon the summit of an isolated mountain would be of great interest as giving data concerning the ascent or descent of air in the day time, or at night along the mountain flanks. Placed upon high factory

chimneys the apparatus would give a clew to the vertical movements of the lower strata of the atmosphere. An interesting example observed at Zi-Ka-Wei was the breaking through of the lower strata by an inclined current during three hours, when it suddenly resumed its former course. This phenomenon lowered notably the temperature. While the wind blew downwards at an angle of about 16° , its horizontal velocity, measured by the Robinson anemometer, varied between 25 and 31 miles per hour; whence it follows that its vertical component was from 7 to 9 miles, giving a vertical pressure of 0.4 pounds per square foot. Such results explain a fact related by Franklin that during a strong wind a pond, 3 feet deep, was emptied at one bank and the water forced up to a depth of 6 feet on the other side.

DIURNAL PERIOD.

In general the inclination of the wind is less before than after noon, the influence of the solar heat to produce ærial currents being evident. In most months the minimum occurs about sunrise and the maximum at the commencement of the afternoon, but in others this law is completely reversed. Apart from the abnormal cases, at night the air is calm and flows quietly at its normal inclination. After 8 o'clock in the morning the anemometer shows by its more and more rapid revolutions that great undulations have begun from the warming effect and the rising of the layers in contact with the ground. These cease suddenly between 5 and 6 o'clock in the evening, and during the night there are plunging winds, except during the passage of deep barometric depressions. In October and November, 1885, the hourly means of the vertical wind velocity during the day was 5,770 feet and 6,637 feet, and during the night 5,032 feet and 5,406 feet, respectively.

It may be asked to what height these currents penetrate into the upper layers of the atmosphere. For the present one can only conjecture, but it may be supposed that the marked slackening observed at midday in the atmospheric currents at high altitudes is occasioned by the obstacle which the rising currents from the lower strata offer to their normal course. As a fact,

these upper currents, as observed on high mountain summits, recover all their intensity during the night, while the lower currents become weaker and flow more horizontally.

MEAN INCLINATION OF EACH WIND.

The winter of 1884-85 gave a maximum positive inclination (ascent) with N.E. winds and a minimum with W.N.W. winds. If the inclinations for each point of the compass are compared with the mean temperatures of the different winds, a remarkable similarity is noted. The maxima of inclination corresponds exactly to the maxima of temperature and the minima to the minima. The N.E. winds are the warmest in winter in the plain of Shanghai, and those from W.N.W. are the coldest on account of the topography of the surrounding country. The winds are warmer at Zi-Ka-Wei in proportion as they have traversed more water, and colder as they have passed over large extents of dry and cold country. Now, to the W.N.W. of Zi-Ka-Wei stretches a great plain with little water, but on the N.E. opens the great gulf which forms part of the Yellow Sea. Thus is naturally explained the distribution of temperature around the horizon of Zi-Ka-Wei, and also the various inclinations of the wind according to the direction from which it blows, for the warm air tends to rise and the cold air to sink.

THE VERTICAL MOVEMENTS IN THEIR RELATION TO THE ATMOSPHERIC PRESSURE.

In comparing the variation of the wind's vertical component with the variation of the barometer, it is seen that the latter rises when the air descends or tends to descend, and that it falls when the air rises. The vertical movements of the air, therefore, produced by solar radiation, are then the principal cause of the changes of the atmospheric pressure. The connection between these currents and the general movements of the atmosphere is seen by the results during October and November, 1885, when the relation of the ascending winds before the passage of a depression to these same winds after the passage, is as 2.0 to 1; the relation of the descending winds after the passage of a depression to these same winds before its passage was as

2.6 to 1; so that it may be said that during the two months the air had five times more tendency to rise at the approach of a depression than when it receded from the station of observation. One fact rules all these phenomena: the positive inclination (ascent) of the wind increases in proportion as the barometer falls and diminishes as the barometer rises again.

The results obtained by Fr. Dechevrens are, as have been seen, encouraging, and it is probable that his example will be followed in Belgium, where at the new Observatory of Uccle regular measures will be made of the inclination and vertical component of the wind's force.

THE MUIR GLACIER.*

BY PROF. J. W. CHICKERING, JR.,
NATIONAL DEAF MUTE COLLEGE, WASHINGTON, D. C.

It is within the memory of many of us that the question has been gravely debated whether inside our territorial limits were to be found any genuine glaciers.

By the acquisition of Alaska, however, that question has been settled very emphatically in the affirmative.

Besides the 65 small residual glaciers of the Sierra Nevadas, of California, at an elevation of about 12,000 feet; and those upon the flanks of Mounts Shasta, Hood, Baker, St. Helens, and Ranier; Professor John Muir in his notes respecting the cruise of the *Courier*, tells us that in Alaska between 50° and 60° N. latitude there are probably more than 5,000 glaciers, great and small, hundreds of the larger descending through the forests nearly to the level of the sea, though as far as at present known only about 25 discharge into the ocean.

North of latitude 62° few, if any, are found, the ground being comparatively low, and the snowfall light.

Passing up Mangell Nanems our eyes are cheered by the sight of Patterson glacier in about latitude 57°, and then as we hold our course northward glaciers cease to be a novelty, and

*Read before the Philosophical Society of Washington, May 7, 1887.

we see them at first high up the mountain sides, and then descending lower and lower till entering Glacier Bay, we find that the coast survey chart does not exaggerate when it tells us, "A glacier in every ravine." Twenty glaciers of respectable size were in sight at once, from the deck of our steamer, several of them attaining titanic proportions.

Professor Muir tells us that between the west side of this bay and the ocean the whole land surface, high and low, with the exception of the summits of the higher peaks, is covered with a mantle of ice from 1,000 to 3,000 feet thick, discharging both east and west through many glacial outlets, and connecting with the great ice-sheet extending in a north-westerly course along the flanks of St. Elias Range. It has been estimated that this ice-sheet is large enough to cover the whole of Switzerland, mountains, glaciers and all, and out of it rise Mt. Fairweather with an altitude of 15,500 feet, and Mt. Crillon 15,900 feet, while still farther north are Mts. St. Elias and Mangel, with an estimated height of 20,000 feet, rising sheer from the sea-level.

Evidently this once formed part of a continuous ice-sheet like that at present covering so much of Greenland, which flowed over the whole region from the mountains as far south as the Straits of San Juan de Fuca, but which since the period of most extended glaciation has been steadily contracting, leaving at present for the most part only the glaciers of the deeper mountain valleys.

Glacier Bay is about thirty miles long, and eight to twelve miles wide, projecting in a northwest direction from Cross Sound.

On either hand are evidences of glacial action, the rocky islands and cliffs, often from 1,000 to 1,500 feet high, are furrowed and polished from bottom to top, while every lateral ravine is filled with its glacier, and generally at the mouth of each is a curved terminal moraine from one to five miles long, often covered with trees of considerable size, and a long way in advance of the present ice-front.

The bay narrows as we sail north, and whole fleets of icebergs come sailing out to meet us, of every size and shape, and exhib-

iting marvelous color effects from snowy whiteness to the deepest conceivable azure.

The bay divides at its head into two inlets. The western and longer has hardly been visited, such is the wealth of unexplored nature.

At the head of the eastern inlet stands the great Muir Glacier, named for the Professor who, with Rev. S. H. Young, went up by canoe in 1879, and first of white men looked upon its grandeur.

We had the good fortune to meet at the glacier foot, as we stepped ashore on the sloping beach of the lateral moraine, Professor G. F. Wright, of Oberlin, O., so well known for his explorations along the southern moraine belt from the Atlantic to the Mississippi, who with two companions was spending a month here in glacial study. From an instructive paper of his in the *American Journal of Science* for January, 1887, I am able to state accurately many facts heretofore only guessed at.

The rocky rift between the mountains through which the glacier breaks is a little over two miles wide. On the east is a triangular beach of glacial detritus, about one mile in width at the upper end, and coming to a point three miles below, where it runs against a perpendicular face of metamorphic slate 1,000 feet in height, with a mountain behind it rising 5,000 feet. On the west, the mountain wall is 2,900 feet.

The width of the glacier as it issues from its rocky banks is 10,664 feet, its curved water front is about one mile, and the height of the perpendicular ice-wall rising from the ocean is from 250 to 300 feet, while a little farther back it is 400 feet, thence rising towards the east and northeast with a slope of about 100 feet to the mile.

The depth of the water at its base is 500 feet, so that the total perpendicular face would be 800 feet, or more than half as high again as the Washington monument.

Nine main streams unite to form the ice-river, and these subdivide into seventeen branches, coming in every direction from fully one-half the horizon on the north; These streams are from twenty to forty miles long, and drain a vast amphitheatre.

Professor Wright found the glacier to have a very high rate of motion, as determined by triangulations from a fixed base line. The centre moved at an average rate, from August 11th to September 2d, of seventy feet a day. Near the margins the motion was ten feet a day, making an average for the whole mass, of forty feet a day. A cross section 5,000 feet long by 700 high, would give 3,500,000 feet, which multiplied by 40 gives 140,000,000 cubic feet as the daily discharge.

The front, during this time, retained its relative position, neither advancing nor retreating, but melting and breaking away as fast as it was pushed forward by the enormous pressure from behind.

Every ten or fifteen minutes comes a crack, a crash, a plunge, a peal as of thunder or heavy artillery, a shower of spray thrown up, and a new iceberg is born. We saw one mass near the center of the ice-front, which we had been watching all day, and which we estimated at 200 feet long, 250 feet above the water, and 100 feet thick, thus topple and crash and plunge. Spray rose as high as the summit, pieces of ice were thrown back upon the top of the ice-wall, there was a shock almost as of an earthquake; great waves sent the bergs crashing against each other, and tossed our steamer as if it were an egg-shell,—and the marvelous display was complete.

The surface of the glacier is, at the sides, where the motion is least, smooth and easy to traverse. In the center it is like the ocean in a storm, so rough as to be almost impassable, with crevices and caverns and clefts down into the azure for hundreds of feet.

Numerous medial moraines stretch away toward the east, the north, and the west, those on the east gradually uniting as they are forced together by the pressure of the more rapidly moving central mass. One contains large blocks of white marble from many miles away.

Rocky peaks rise from 1,000 to 3,000 feet above the surface of the glacier, like islands in the midst of a mighty river, with the ice heaped up several hundred feet on the upper side, and with a corresponding eddy-like depression below, while a little farther

on the two streams thus divided unite again at a common level.

From under the glacier are constantly flowing several rivers, with sufficient volume of water to keep the area around their mouths quite free from floating ice.

One of these streams on the west side is cutting through the gravel deposit, more than 100 feet thick, and thus uncovering a buried forest of large cedars in perfect preservation, one tree being ten feet in circumference, fifteen feet above the roots.

This glacier formerly filled the whole bay, but is now receding with such rapidity that the shores and islands of the upper part are bare of forests, and the rocks exhibit comparatively fresh glacial grooves and striæ for several hundred feet above the present water line.

This region is very favorable for study of glacial action, being perfectly accessible, by weekly steamers, with very little of exposure or discomfort, save the abundant moisture.

It is to be hoped that this interesting and little known part of our country will no longer be neglected either by the scientist or the government, and that at no distant date a well-equipped exploring exhibition may be sent thither.

CORRESPONDENCE.

THE WESTERLY WINDS AND STORM SYSTEMS OF THE TEMPERATE ZONES.

To the Editors: The following observations are addressed simply from the standpoint of an inquirer, not of a professional meteorologist.

Between the tropics a familiar system of circulation of the winds prevails. The surface currents flow from the colder to the warmer latitudes, and the return currents overflow above. Beyond the tropics, however, according to the accepted theory of meteorologists, this order is reversed. The overflow of the trades impels a surface current from a warmer to a colder latitude which returns again as an upper current,—or at least as a current midway between the overflow and the surface. Such

a system of circulation naturally suggests a condition of unstable equilibrium. The tendency must be to invert the normal gradient of temperature with altitude since the colder return current flows over the warmer. The prevailing westerly winds throughout the observed latitudes beyond the tropics would seem sufficient proof that the general tendency of these winds was towards the poles, for in no other way can their resistance to the tortional force of the earth's rotation be explained. Admitting then a general tendency of the winds in the temperate zones, impelled by the overflow of the anti-trades to flow out from beneath in the direction of the poles, would not the abnormal conditions of temperature combined with the tortional force of the earth's rotation tend to generate a series of eddying movements throughout the system in which the warmer air beneath would, from time to time, ascend and join the return current above? Are not the alternating areas of low pressure which are continually moving round the earth, chargeable to great aërial eddies primarily induced by the abnormal temperature character of this circulatory system? If so it would naturally follow that the downflow from adjacent regions of high barometer should be less than the up draft, the difference being made up by the general surface movements of the air from the region of permanently higher barometer towards the tropics.

If this theory be the correct one, instead of a uniform circulatory system like that of the trades, we should have for the temperate zones a system of irregular eddying movements in which the polar surface current was being continually transferred to the return current above, and there would remain no large component of air requiring the assumption of an extensive polar calm belt with an updraft for its return. The variable character of the winds too throughout the temperate zones, as well as the wide fluctuations in the barometer contrasted with their steadiness between the tropics seem to favor this conception of the real character of the general circulation throughout the temperate zones, aside from the effects of merely local temperature disturbances.

Professor Ferrel has mathematically demonstrated that the gyrotory force of rotation on the principle of the conservation of areas, must result in a maximum pressure at about latitude 35° with descending gradients to the Equator and the Poles. The popular explanation is that the converging meridians cause this bulging up. *A priori*, it would seem more natural to expect that the outflow from this tropical belt should in the temperate zones be restricted to a narrow space, that through the combined influence of temperature and gyration, a second calm belt should be found somewhat nearer the Pole with an ascending current formed by an indraft of air, both from the Tropic and the Pole, and an overflow above in both directions, or perhaps a succession of belts of descending and ascending currents, with distances apart determined by the effect of temperature and of gyration, which would be a function of the velocity and of friction. Such a system would be normal in its relation to the diminution of temperature with latitude. The prevailing under-currents would then flow from the colder to the warmer latitudes. But such seems not to be the case in nature. The question with the writer is whether the conflicting influences of the diminishing pressure and diminishing temperature with increase of latitude, do not result in a rude compromise in the shape of great ærial eddies, producing the succession of high and low pressure areas so characteristic of the extra-tropical zones?

WALTER S. NICHOLS.

CURRENT NOTES.

J. C. HOUZEAU.—In the death of this eminent scientist Americans can take an interest even greater than that due to the loss to science. Houzeau was a democrat, and was early attracted to America. Just before the late Civil War he came to this country and settled in Texas, near San Antonio. He was a strong anti-slavery man, and on the breaking out of the war his position became more than uncomfortable, until it was dangerous. He finally made his escape as a mule-driver to Mexico, but had to sacrifice the most of the collections and manuscripts which he

had laboriously collected for four years. After a short residence there he came to New Orleans, then in Federal hands, though by no means fully subdued, and started an anti-slavery paper in English and French. In 1870 he went to Jamaica, and in 1876 to Belgium, to assume the directorship of the Belgian Observatory, as a worthy successor of Quetelet, who had died two years before.

Houzeau was born in 1820, and came to this country in 1857. His activity was divided among many fields, of which meteorology was one. He published a meteorology along with M. Lancaster, and also a climatology, a work on the physics of the globe and on the physical geography of Belgium. His *Vade mecum de l'astronome* and his *Bibliographie générale de l'astronomie* have earned him the lasting gratitude of astronomers. The latter was left unfinished; but on it he had the collaboration of M. Lancaster, who will doubtless complete it. M. Houzeau was a philanthropist, a free thinker, a friend of the poor and of workingmen, a genial and very attractive character, and a man of encyclopædic learning.

ROSE HEDGES VERSUS SNOW FENCES.—Our snow fences are so ugly, and so expensive to make and repair, that it would be perhaps profitable, certainly agreeable to travellers, if our railway authorities would adopt a method of protection from drifting snow which is used in Hungary. We take the following from Symons's *Magazine*, which quotes it from the *Globe*:

"A rose-hedge is now said to be the most effective defense. More than a mile of one of the Hungarian railways has been this winter kept clear of drifts by a rose-hedge about $6\frac{1}{2}$ feet high and $3\frac{1}{4}$ feet thick, although this section of the line had always in previous years been liable to be blocked. The rose best adapted for this purpose is the rose of Provins, now incorrectly corrupted into the rose of Provence. But doubtless there are many other kinds equally serviceable. The essential thing is that the hedge shall offer a solid obstacle to the drifting snow. It will be a great improvement, certainly—apart from all practical considerations—if we could be induced to make our lines

of railway blossom with the rose. At present the banks which border our lines are neither useful nor ornamental. Here and there a little kitchen garden flourishes, or a fowl-keeping station-master cultivates sunflowers for his birds. But there is no serious attempt either to grow cabbages or cabbage roses along the lines. In Brittany the lines run between small fruit-gardens, with innumerable pear and apple trees trained espalier fashion at the sides; and the practical cultivation of fruit-trees is adopted along the high-roads in Germany. We might take a leaf out of our neighbors' books either in the useful or the ornamental direction."

WEATHER PREDICTIONS: MR. BLODGET'S RAINFALL MAPS.*—

* * * * * I was the first, in 1852, to use the telegraph to obtain warning of storms. I did this at the Smithsonian Institute by the favor of Hon. Amos Kendall, then president of the United Telegraph Lines, and I sent the first charts to the British Association for the Advancement of Science in September of that year, by the hand of Prof. W. B. Rogers. It is true, that I gave the chief place to the constants of climate, as I prefer to call them, in my *Climatology*, but I have always followed the discussion of storms with interest, and have been to some extent an adviser with the Signal Service. I was impatient with the theories of Espy, Redfield, and others, of that early period, and thought it then better to represent the mean or constant conditions, and to educe them from what appeared to me to be their general laws, even if the data should be insufficient to give them as facts.

So when my good friend, Dr. Ruschenberger, looked somewhat critically at my rain shadings for the Superior and Pacific coast, and asked if I was sure such was the distribution, I said to him that if such was not the actual rainfall, the charts showed *what ought to be the quantity*, admitting the insufficiency of my materials.

I am watching the discussion with great interest, and have

* We print this, a part, from a private letter, with the consent of the writer, LORIN BLODGET.

just written to Hon. S. S. Cox, House of Representatives, to ask if he has made any general researches showing the analogy of the American interior climate with that of Spain, as cited in his speech in the House of September 1 (in the *Congressional Record* of September 2, p. 9031).

I do not at the moment recall Dr. Chas. Denison's charts, as referred to by you in the December number of your JOURNAL. Were they in the Signal Service Reports?

I see very little to change in the general position of my Rain Illustrations as given in my *Climatology*. I am now reviewing one section after another, a work of great labor. They generally reported smaller quantities at the old military posts than are now measured at the Signal stations. But this, as I now think, was due to the occasional lapses in observation, and to the bad position of the instruments.

I also think that the illustrations I then gave of the Lake Districts were somewhat deficient, but have not revised those districts as yet.

Your article in the December number of 1887 was a just and valuable one, and I thank you for bringing it to my attention.

PHILADELPHIA, September 5, 1888.

HINMAN'S ECLECTIC PHYSICAL GEOGRAPHY.—This is a 12mo. book of 382 pages, well illustrated, and packed full of information suitable for young pupils. Its illustrations are new and its charts numerous and intelligible, and, in general, there is a freshness and clearness about the book which make it attractive. The order of treatment is more logical than that of its predecessors. It is not easy, in such a pot-pourri as physical geography must from its nature be, to strike out a natural sequence and preserve a just perspective; but the author of this little work has succeeded, in our opinion, better than his predecessors in this respect. Meteorology and climatology occupy relatively more space than is usually given to them. On the other hand, the biological sciences occupy less, while very little attention is given to the distribution of animals and plants. In this last respect the author is in line with recent makers of similar books

abroad; but we think it somewhat unfortunate, as there is much valuable information on common objects which can be given to pupils in this line which they will get nowhere else in their educational course.

Such a book as this could properly serve as an introduction to several sciences, and would come within the comprehension of pupils in the lower classes of our high schools. We can commend the book, also, to a class of more mature readers who wish to get a clear and brief statement of the admitted and fundamental principles of such rapidly changing sciences as meteorology or geology. The presence of an index increases the value of the book to this class of readers.

UPPER AIR CURRENTS.—Professor Hazen, of the Signal Service, discusses this topic in a recent number of the *Journal of the Franklin Institute*. The study is based on the observations on Mt. Washington, and the article contains many suggestions of value for the farther discussion of the subject. We take the space only to give Professor Hazen's conclusions. These are:

(1) The upper currents of the atmosphere, while having a general motion to the eastward, at the same time have a motion about high and low areas similar to that of surface winds. (2) The motions of upper cirrus clouds, in general, are similar to that of the currents at about 6,000 feet elevation. (3) The velocity of the currents at about 6,000 feet is less by half at a high area than it is at a low area. This may be an explanation of the fact that the maximum daily winds at mountain stations come at about sunrise, and the minimum at the hottest part of the day. May not the heat after the middle of the day expand the air sufficiently to cause a rise in pressure somewhat similar to a high area, and hence the diminution of the wind velocity? (4) If the progressive motion of storms is dependent on that of the general upper air currents, then the motion of the lower clouds, or at least those below 6,000 feet, must indicate much more clearly the direction of the storm than the upper clouds. (5) It would seem possible to determine quite closely the path of an advancing low area if we know the height and direction of the

clouds in front of it. (6) It seems probable, from the enormous increase of velocity of the upper currents in the neighborhood of a low area, that this rapid increase in velocity will account, if not entirely, still largely, for the intensity of the storm. (7) It was determined in 1884 that thunder-storms, in the southeast quadrant of a low area and often 600 miles from its center, frequently attained a velocity double that of the accompanying low area; that they gained upon the low area during the day hours, to die out at night and begin again at a point a little east of the point where they began the day before (perhaps about as far east of that point as the low area had moved toward the east), and from thence repeat the movements of the previous day. I throw out, says Mr. Hazen, as a suggestion, that possibly these storms rise to a height somewhat in excess of that of the "power" of the low area, and hence, having reached a current moving more rapidly, they are transported much more rapidly. This would be a plausible explanation if we consider that the progressive motion of the low area is caused by that of the current wherein its power is seated.

THUNDER-STORMS AT BRUSSELS have been much more common this June than for many years past. There is some evidence that since the erection of Melsen's complex and effective lightning conductor on the tower of the Hotel de Ville, they have not had nearly so many thunder-storms in the city. But this tower commands the southwestern part of the city and, while thunder-storms usually come from that direction, these come from the east.

The lightning flashes in some of these storms were extremely vivid. Several persons remarked in one of them that the rain-drops were shining, and one observer saw the strokes followed by shining traces in the air, something like those which follow shooting stars. An interesting fact is that, in one case, at the instant of the stroke of wind which announced the advent of the storm, the flags which had been hanging loosely suddenly erected themselves toward the sky, thus showing in that case the presence of an ascending current in front of the storm.

M. Lancaster thinks that the following principles are true for Belgium thunder-storms and, *mutatis mutandis*, for these storms generally.

1. The storms appear in connection with areas of low pressure, more generally when this area is from west to northwest of the locality occupied by the thunder-storm. For Belgium the electric phenomena attain their maximum when the focus of the general storm is over or near Ireland.

2. Thunder-storms are most likely to occur when the barometer (reduced to sea-level) stands at from 29.5 to 29.7 inches. In high pressures they are rare, local, and of little intensity. In Belgium they occur only in the mountainous part of the country.

3. The storms travel generally from southwest to northeast at a speed of 25 to 30 miles per hour. The rainfall accompanying them decreases toward the east.

4. Their production depends on the state of two important meteorological factors, pressure and temperature. A high temperature at the time of a barometric depression is the most favorable condition. The hour when they are most common is that which falls nearest to the thermometric maximum and barometric minimum.

5. A feeble gradient favors their production.

CHINA'S SORROW.—The Hoang-Ho derives its name, which translated means yellow water, from its color due to the loose shifting yellow soil through which it flows in its middle part, and to this, too, is due its name of China's Sorrow. This soil is carried down to the immense delta of eastern China and is there deposited in the bed of the river, thus raising it and necessitating embankments. It is estimated that the river is sometimes from 15 to 40 feet above the surrounding plain. Moreover, the river is especially subject to summer and autumn floods, which, notwithstanding the extreme care expended on the river by the government, often break through the embankments and flood the surrounding rich and thickly populated plain. As the plain is level the river may at such times entirely change its course, and

its mouth has in latter times changed from the south to the north side of the Shantung promontory, a distance of about 300 miles.

Chinese history records nine changes of course. The first was in 2200 to 2300 B. C., and is very celebrated in Chinese annals because of the success of the great Yü in bridling the river. His labors as recorded were greater and more remarkable than those of Hercules, and, however legendary they may be, they were effective, for the next outbreak did not occur for 1500 years, or in 602 B. C.

The last historic outbreak was in 1851, when the river changed its course to the north and its mouth from latitude 34 N. to latitude 38 N. In the outburst of last year the river made an attempt to resume the old course but, so far, has only terminated the effort with a series of lakes; but it may succeed with the overflows of this year. If this last outflow of the river was not successful in completely changing its mouth, it at least succeeded in causing much destruction. Some cities and hundreds of villages were destroyed. A large and populous area was overflowed, and it is estimated by foreigners at Peking that nine millions of people lost their lives in the flood. The imagination can hardly grasp a catastrophe of such a magnitude, but notwithstanding its magnitude, Chinese charity (governmental and private) has been in proportion, and Chinese industry, with the necessary complements of any requisite number of men and amount of money, with the skill acquired by 4000 years of practice, is fully occupied in retrieving the damage and preventing future outbreaks. It is possible, however, that the task is too great, and that another overflow has occurred or will occur this year.

METEOROLOGY AT THE CINCINNATI EXPOSITION.—The display of articles relating to meteorology and terrestrial magnetism is confined to the U. S. Government exhibit. The Signal Service shows the instruments ordinarily used at one of its second order stations, with a few other instruments, but excepting the anemograph the only continuous register is the Draper thermograph. There is shown the cyclostyle apparatus for printing the cur-

rent data on the daily weather maps which are now issued from many local stations.

The Coast and Geodetic Survey have a number of instruments which merit notice. Among them is the Pillsbury deep-sea current meter, which has been successfully used in the Gulf Stream at a depth of more than one thousand fathoms. It consists essentially of a thin metal rudder, to which is attached a small cup-wheel, turning in a vertical plane, which has its revolutions registered by differential wheels. Below the rudder is a compass bowl hung in gimbals, with a device for clamping fast the compass needle and rudder by a propeller fan when the instrument is drawn upwards through the water. The angle between the needle and rudder is thus fixed, and with the revolutions of the cup-wheel can be read when the instrument is taken from the water. A deep-sea thermometer of Casella, on the Six system, for registering maximum and minimum temperatures, has been used at a depth of more than five miles.

The magnetic apparatus comprises a unifilar magnetometer for the determination of the magnetic declination and horizontal intensity, and of a Casella dip-circle for the determination of the vertical and total intensity. There are also the Brooke magnetometer, consisting of a unifilar declinometer, a bifilar horizontal force magnetometer, and a Lloyd's balance or vertical force magnetometer, arranged round three central-reading telescopes, so that one observer may almost simultaneously read the three instruments.

A number of charts show the distribution of the earth's magnetism over the United States in January, 1885. The first gives the isogonic curves, or lines of equal magnetic declination for each five degrees from the true meridian. The line of 0° declination runs from the Lakes to the Carolina coast, while the lines of east and west declination, diverging southward, lie respectively to the west and east of it. The amount of declination reaches 20° on the New Brunswick and north Pacific coasts. Another chart shows the isoclinic curves, or lines of equal magnetic inclination, for each five degrees from the horizontal plane. In the northern hemisphere the dip is downwards, and in the

United States the isoclinic curves are nearly concentric, and increase tolerably regularly with the latitude from 55° in the south to 75° in the northern portion. Other charts show the isodynamic curves, which are lines of equal intensity of the horizontal component, or of the total magnetic force, given in both the old English units and in the new C. G. S. units.

The Hydrographic Office displays the instruments used in its surveys, besides log-books, pilot-charts and other publications. Among the latter is a barometric chart of the great storm which raged off the Atlantic coast from March 11 to 14 of this year, compiled from the records of the Signal Service stations and of vessels. The Geographical Survey shows some colored charts by Henry Gannett with the annual distribution of the precipitation and relative humidity over the United States. The maximum precipitation occurs on the north Pacific and Gulf coasts. The maximum relative humidity is also in the former region, and is high on the Atlantic and Gulf coasts and in the Lake Region. It is interesting to compare the effect of the excess of these two elements upon the relative prevalence of deaths from malarial fever and from consumption as given on some charts exhibited by the Census Office. Malarial fever is most fatal on the North Carolina coast, in Florida, Alabama, Arkansas, and in the western portion of New Mexico, while consumption, on the contrary, causes the greatest number of deaths in northern New England and the next greatest number in the Ohio Valley and on the California coast. It is evident, therefore, that precipitation and relative humidity are not the only climatic conditions which affect the mortality by malarial fever and by consumption.

A. L. R.

BRIEF NOTES ON VARIOUS SUBJECTS.—The Canadian *Weather Review* records a fall of 2.02 inches of rain in $2\frac{1}{2}$ hours at Richmond, Province of Quebec, on June 14th. It is the heaviest rainfall ever recorded there. The 6th of June was a day of many thunder-storms. At Minden large pieces of ice fell, stripping forest trees.—The U. S. *Monthly Weather Review* publishes monthly now a list of heavy rainfalls within its territory

for the month. It is of very great interest, and we hope to have something farther to say about it when the year is completed.—The same journal contains monthly much valuable matter in the form of long time records of meteorological elements. For instance, the issue for May gives the annual mean temperatures at Philadelphia for 110 years, and the coldest days at Thompson, Conn., for 100 years.—Apropos of a change of climate in the West, we take the following extract from J. B. Harrison's "The Latest Studies on Indian Reservations." Mr. Harrison says: "It is evident that in all that region the earlier unfavorable estimates of the agricultural capabilities of the Indian country have been considerably modified. The tendency now is toward extremely sanguine judgments and expectations. The white people say that the rainfall has increased to a surprising extent, and they are confident that during the next few years it will increase in still greater proportions."—The newspaper reporters often use glowing language concerning the great phenomena of meteorology, such as tornadoes, blizzards, and thunder-storms, but the following is the first of the sort which we have seen in which the thermometer is misused. We clip it from the *Downington Review*, as we have not the pleasure of exchanging with the paper in question: "The advent of summer in the South is described by an editor in appropriately glowing language: 'The mercury, like a cringing sycophant, quick to do homage to the coming queen, bounded up toward the nineties, and the glowing sunshine showered upon the woods and fields and sweltering mortals like wavering sprays of molten gold.'"—One of the interesting features of the approaching French exhibition is to be a model of the earth made on the scale of one-millionth. It is to be accurately constructed, and will rotate on its axis. Even on this scale it will be an enormous object, nearly 21 feet in diameter.—Major Powell, head of the National Geological Survey, lays down the proposition that "the cutting power of a stream increases rapidly with the increase of sedimentary load." It is a text from which many sermons might be preached, and Major Powell has preached one in applying the principle to the control of the lower Mississippi river.—The activity of Lieu-

tenant Finley must be very great, and is effective in results. We have on our table a new publication on tornadoes by him, which we will notice more fully at another time. And now we are in receipt of a circular advising the public of the publication of a set of 15 storm-track charts for the North Atlantic Ocean. A resolution before the House of Representatives recommends their publication for public distribution.—Important publications for seismologists are the two lists of earthquakes in Mexico and California. The former runs through several numbers of the *Memorias de la Sociedad científica "Antonio Alzate"* of Mexico, and is edited by Don Juan Orozco y Berra. It begins with the Aztec records in 1460, and includes many hundred earthquakes, in some cases in much detail. It ends at the current year. The difficulties of deciphering the Aztec records are unknown to us, but we have noticed in the year 1507, when an earthquake is said to have accompanied an eclipse of the sun, no such eclipse could have been visible in Mexico. The nearest one we can find is in 1496. The California list is by Dr. Holden, director of the Lick Observatory. The territory covered includes also Lower California, Oregon, and Washington Territory, and the list is published by the State. This list begins in 1769. It includes many hundreds of earthquakes, of which, however, only 24 have been serious since 1800. Dr. Holden makes some interesting studies of their relations to the seasons, etc. It seems that earthquake records make part of the regular work of the Lick Observatory.

HAND-BOOK OF METEOROLOGICAL TABLES. By Henry Allen Hazen, A. M., Assistant Professor, Signal Office. Washington, 1888. (Press of the Register Publishing Company, Ann Arbor, Michigan.) Pp. 127.

This book of tables will be gladly welcomed by meteorological workers in this country, for such a work has long been needed. The extensive but expensive Smithsonian Tables by Guyot and the tables scattered through the Signal Service publications, and the small collection of tables by the latter, have been about all that have been heretofore accessible to most of our meteorologists, so that we owe Professor Hazen more than thanks for

his publishing (no publisher's name is given, so it is assumed that the author has acted as publisher himself) in a convenient form the forty-five tables found in his collection.

In the preface the author states the plan of the work, and makes a few remarks concerning the formation of the tables and their authorship. We wish that he had given still more information in the preface concerning the construction of the tables, for the sake of those who are unfamiliar with them, but he probably wished to keep his book within certain limits as to size; he has, however, given a short explanatory introduction to each of the different classes of tables. The list of tables is as follows: Temperature tables: Conversion of F° into C° , conversion of C° into F° , conversion of C° and F° near the boiling point, $F^{\circ} = C^{\circ}$, $C^{\circ} = F^{\circ}$, intensity of solar radiation, temperature of ascending saturated air. Pressure tables: English scale barometer to freezing, metrical scale barometer to freezing, English barometric determination of heights, metrical barometric determination of heights, English barometer observations reduced to sea-level, column of air equal to .1 inch in the barometer, column of air equal to .1 mm. in the barometer, metrical barometer readings reduced to sea-level, gravity correction, English and metrical pressures corresponding to boiling point. Humidity tables: English and metrical vapor pressures, decrease of vapor pressure with altitude, English and metrical weight of vapor, dew-point and relative humidity for both F° and C° . Wind tables: Lambert's formula, conversion of wind velocities: miles = meters, feet; kilometers and metres = miles; wind velocity and pressure miles = pounds per square foot, Beaufort's scale; estimation of wind velocity; estimation of thunder-storm intensity. Linear tables: inches to millimeters, millimeters to inches, meters to feet, miles to kilometers, statute to nautical miles, length of a degree. Miscellaneous tables: sunspot numbers, local to standard time, time of sunrise, to determine the position of a point on a map, tables for dividing by 29, by 28, by 31, normal pressure and temperature in U. S., mean wind direction in U. S., normals for the U. S.: plate I, January; plate II, July.

The type and arrangement of the tables is good, and the author has done a good thing by including several tables not usually given, but which are necessary to the meteorologist and which one usually has to prepare for himself. Many of the tables have been computed by the author, and he has marked these "original," while those he has copied from the writings of others or has taken from other collections of tables he has referred to their proper authority. While there are some minor points in connection with some of the tables with which I cannot wholly agree with the author, yet I heartily recommend them to all of our workers in meteorology, and do not see how any of our American meteorologists can afford to be without a copy. Prof. Hazen is one of our most active meteorologists, and the fact that he has for years used many of these tables in manuscript, speaks well for their accuracy and convenience. I expect to use the tables almost daily in my own work.

FRANK WALDO.

THE CLOSING OF THE U. S. SIGNAL SERVICE STATIONS ON PIKE'S PEAK AND MT. WASHINGTON.—It is greatly to be regretted that the Chief Signal Officer has found it necessary to close—temporarily at least—the stations on Pike's Peak and Mount Washington. Observations at the former station were discontinued September 30 of this year, and the instruments brought down to Colorado Springs. The Mt. Washington station was closed last autumn, but was re-opened the past summer; and it is understood that if these two stations are to be operated in the near future, it will be during the summer months only. The reason for the interruption of the continuous series of observations which have been maintained on Pike's Peak for the last fifteen years, and on Mt. Washington for seventeen years, is said to be lack of funds, for under a strict interpretation of the law by which the appropriation for the Signal Service is granted by Congress, this money must be expended only in the interest of weather predictions. Now it is claimed that the observations made on Pike's Peak and Mt. Washington were of no practical use as regards weather predictions, although up to last year the

tri-daily observations from Mt. Washington were telegraphed to the central office at Washington, and for some time, while the telegraph line was intact, the observations on Pike's Peak were similarly transmitted to Washington.

It will be a source of great regret to meteorologists the world over to learn that the only mountain-top stations in the United States are to be discontinued. Pike's Peak, as the highest station in the world, is particularly valuable for the study of the movements of the upper atmospheric currents, while Mt. Washington is situated in the usual storm track. The valuable contributions which this last station has made, and might continue to make, to meteorology, were summed up in Professor H. A. Hazen's article in the September JOURNAL. It may not be generally known that the detailed observations made on Pike's Peak during the first fourteen years are about to be published by Professor E. C. Pickering, the director of the Harvard College Observatory, in the *Annals* of that institution. Hitherto, *résumés* only of the Pike's Peak and Mt. Washington observations have been published in the *Reports of the Chief Signal Officer*, and this timely action of Professor Pickering will be especially welcome to European meteorologists, who have published the observations at their mountain stations *in extenso*, and have complained that similar details of the work of the American stations were not accessible.

The Colorado College, in co-operation with the Signal Service, maintains a meteorological observatory at Colorado Springs, which is about eight thousand feet below the Peak and 12 miles distant from it. This observatory, therefore, is well situated to use as a normal base-station with which to compare the Peak observations. The Colorado College Observatory possesses a number of self-recording instruments, including a Richard thermograph. These thermographs have been supplied to the Peak and to an intermediate station by Professor Pickering, who is studying the suitability of Colorado as a site for a mountain astronomical observatory. The study of these thermograph records alone is of great interest, and it is therefore natural that the Colorado Meteorological Association should deplore the

abandonment of the Pike's Peak station. If permission can be had from the United States Government, which owns the reservation upon which stands the signal station on Pike's Peak, it may be possible to maintain a meteorological station there, to continue the regular observations and to undertake special investigations, defraying the expense by the income derived from feeding and lodging tourists, this being a plan frequently employed in Europe to provide for the maintenance of the mountain meteorological stations. To accomplish this object, a bill for a twenty years' lease of the United States Military Reservation on Pike's Peak to the Pike's Peak Astronomical and Meteorological Society has recently been introduced into Congress by Senator Teller. If this scheme can be consummated, as we trust will be the case, we can confidently expect interesting results from the series of observations made at the high and low level stations under the able superintendence of Professor F. H. Loud, the director of observations of the Colorado Meteorological Association.

A. L. R.

HISTORY OF THE GREAT LOG RAFT.—So much excitement and apprehension were created by the abandonment, off Nantucket south shoal last December, of a gigantic log raft, that reports of vessels have been watched with the greatest interest in order to ascertain the general direction in which the logs would drift, and the casualties, if any, likely to be caused by collision with them. Special care has been taken by this Office to collect all available data on the subject, as shown by the accompanying tabulated statement of reports of logs, as well as of timber of a character resembling in any way the logs of the great raft. The following, quoted from the January Pilot Chart, will be of interest in this connection:

December 8.—A gigantic lumber raft, built near Port Joggins, Nova Scotia, starts from the bay of Fundy for New York in tow of the steamship "Miranda."

December 18.—After having weathered several gales successfully, a hurricane is encountered about 40 miles S.S.W. from Nantucket south shoal light-ship; the great 15-inch towing

hawser parts under the tremendous strain; the 10-inch hawser carries away the steamer's bits and part of her deck, and the huge raft gets adrift in the track of commerce—latitude $46^{\circ} 16'$ N., longitude $70^{\circ} 06'$ W.

December 20.—The news reaches New York, creating intense excitement. Outgoing vessels are warned of the dangerous obstruction, and the Maritime Exchange telegraphs for Government aid in finding the derelict raft and warning incoming vessels.

December 21.—The U. S. S. "Enterprise" sails from New York at three hours' notice, followed the next day by the ocean tug "B. W. Morse," and on the 23d by the U. S. revenue steamer "Grant," to search for the derelict and to warn commerce of the danger.

December 24.—The "Enterprise" finds the remnants of the big raft scattered over a wide area in latitude $39^{\circ} 33'$ N., longitude $68^{\circ} 10'$ W., about 100 miles E.S.E. from where abandoned and broken up in the hurricane just six days before.

December 25.—The news is telegraphed from New London on the arrival of the "Enterprise," and apprehension greatly allayed. Reports received a few days later from other vessels confirm the fact that, instead of the gigantic raft itself, only the logs of which it was built are to be looked out for.

The above is a brief history of one of the most dangerous obstructions to navigation which has ever been recorded on this Chart, and the fact that this great raft has broken up before causing some great disaster is good cause for congratulation. While there is still danger from the thousands of great logs of which it is composed, yet it is insignificant compared to that from the raft itself, if it were still intact and adrift in the track of commerce. A mere statement of its character and dimensions is enough to convince any one of this fact. About 27,000 trunks of trees, from 50 to 100 feet in length, were bound together with chains and withes into a huge cigar-shaped raft 560 feet long, 65 feet wide, 38 feet deep, drawing $19\frac{1}{2}$ feet of water when afloat, and of an estimated weight of 11,000 tons.

At least one advantage has been gained by the unparalleled

interest and attention elicited by the exciting incidents attending the loss and search of this great derelict raft, and the reports so frequently received from vessels that have sighted these drifting logs. Public attention has been called in a most forcible manner to a class of dangers on the high seas which it has been the constant effort of this Office to diminish, not only by warning navigators of their presence and position, but by taking prompt action to have them removed, whenever it is possible to do so. Last year 516 derelict vessels, wrecks, and buoys adrift were plotted on the Pilot Chart in their latest reported positions, and the data regarding these dangerous obstructions to navigation are becoming more and more complete and reliable every month. This result has only been reached by means of the cordial assistance of masters of vessels of every nationality, and the effect is already strongly and practically shown by the success which has attended the efforts of this Office in furthering the interests of the maritime community.

What precedes is from the Pilot Chart. With characteristic enterprise the Hydrographic Office issues a supplement to the August Pilot Chart, on which is mapped the progress of the logs. They were abandoned in about latitude 40° , and they have since that time travelled eastward, spreading out somewhat fanwise, more to the south than to the north. At the latest reports the lowest latitude was about 31° ; the highest mapped is about 42° . As to longitudes, in May and June they were generally between 30° and 50° West. On June 29 several of them reached the Azores. As these logs lie in the water and catch but little wind, they can be taken to show the surface drift of the North Atlantic in latitude 40° . It is almost eastward, with a slightly southward tendency.

METEOROLOGICAL CONVENIENCES.—Mr. J. E. Terborg, of Pekin, Illinois, sends us a very convenient and compact graphical monthly record of the elements, also a table facilitating the conversion of the thermometric scales, one into the other. He also proposes a new scale not very different from that of Fahrenheit. Copies can be obtained by addressing Mr. Terborg.



DRAPER'S SELF-RECORDING THERMOMETER.

DESCRIPTION OF THE INSTRUMENT
AND DIRECTIONS FOR ITS USE.



SIZE 14 BY 20 INCHES.

Protected by Letters Patent in the United States, Canada, Great Britain, France, Germany, Austria, Hungary and Belgium.

STANDARDIZED AND WARRANTED.

MANUFACTURED BY THE
DRAPER MANUFACTURING COMPANY,
152 FRONT STREET, NEW YORK CITY.

This thermometer gives a permanent and continuous record in ink of the temperature. The chart indicating hours of the day and days of the week, gives the degrees of temperature from 20° below zero to 110° above. All instruments are accurately adjusted and warranted. The record is easily read and absolutely correct. Sold by the leading instrument dealers and opticians throughout the United States and Canada, and by

The DRAPER
MANUFACTURING CO.,

Owners of the United States and foreign patents, 152 Front Street, New York.



BAILEY'S 30 INCH COSMOSPHERE

With metal coverings and constellation figures is worth "all the Globes and Tellurians ever constructed for making plain the causes of Celestial phenomena." "The constellations and their motions are shown in correct position and not reversed as in the ordinary Celestial globes."

"The changes of seasons and varying length of days are clearly shown." "An indispensable help in teaching Astronomical facts."

Correspondence solicited with one good teacher in each State who has the ability to sell goods and time to devote to it. Address

MICHIGAN SCHOOL FURNITURE CO.,
Northville, Wayne Co., Mich.

STANDARD THERMOMETER.

LEGIBLE.

5 inch Dial.

\$3.00.



(Metallic.)

ACCURATE.

8 inch Dial.

\$4.00

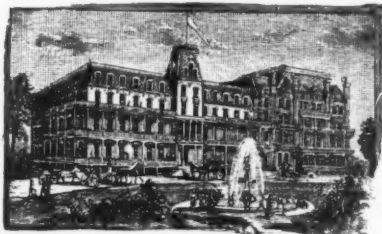
Special Thermometers for Meteorologists with or without Telemeter attachments.

AGENTS:

THE FAIRBANKS SCALE HOUSES

In the principal cities of the United States.

Medical and Surgical Sanitarium, Battle Creek, Michigan.



THE LARGEST SANITARIUM IN THE WORLD.

This Institute has for many years enjoyed an increasing patronage from all parts of the United States and Canada, during which time more than 10,000 Patients have enjoyed the benefits of its unrivaled facilities for the treatment of all forms of Chronic Diseases, including special departments for the Eye, Ear, Throat, and Lungs, together with diseases peculiar to each sex. Every Remedial Agent of Known Value is Employed.

The managers have spared no expense to perfect the appliances of the Establishment to the highest degree, and regardless of cost; and a personal acquaintance with the leading Sanitariums of both this country and Europe, enables us to say that no where else in the world can the invalid in search of health find so great an assemblage of means and appliances for combating disease as found here.

Address, for circulars and further information, inclosing stamp,

SANITARIUM, Battle Creek, Mich.